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In the UNITED STATES PATENT AND TRADEMARK OFFICE

First Named Inventor: Roswell J. Ruka

Application No. 10/663,949 Atty. Docket No: 2003P07614US

Filed: September 16, 2003

Title: PLASMA SPRAYED CERAMIC-METAL FUEL ELECTRODE

Examiner: Keith D. Walker Art Unit: 1745

➡ **FACSIMILE ATTN TO: KEITH D. WALKER** **FAX NO.: 571-273-8300**

APPELLANT'S BRIEF AND RESPONSE TO NOTICE OF NON-COMPLIANT APPEAL BRIEF

Commissioner for Patents
Alexandria, VA 22313

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Filing Date	September 16, 2003
First Named Inventor	Roswell J. Ruka
Art Unit	1745
Examiner Name	Keith D. Walker
Attorney Docket Number	2003P07614US
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PATENT
Attorney Docket No. 2003P07614US

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:

Inventor:	R. Ruka et al.	)	Group Art Unit:	1745
Serial No.:	10/663,949	)	Examiner:	K. Walker
Filed:	September 16, 2003	)		

Title: PLASMA SPRAYED CERAMIC-METAL FUEL ELECTRODE

Commissioner For Patents
PO BOX 1450
Alexandria, VA. 222313-1450

Sir:

APPELLANTS BRIEF AND RESPONSE TO NOTICE OF NONCOMPLIANT BRIEF

This Appeal Brief relates to an appeal from the fifth rejection of claims 1-18 in the Office Action mailed August, 25, 2006 and the Notice of Noncompliant Brief mailed November 15, 2006. This Appeal Brief supersedes and replaces the Appeal Brief filed October 31, 2006.

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Real Party in Interest

This application is assigned to Siemens Power Generation, Inc. (f/k/a Siemens Westinghouse Power Corporation), a Delaware corporation having a principle place of business in Orlando, Florida. Siemens Power Generation, Inc, is a wholly owned subsidiary of Siemens Corporation of Iselin, New Jersey.

Related Appeals and Interferences

There are no prior and pending appeals, interferences or judicial proceedings known to Applicants, Applicants' legal representative, or Assignee which may be related to, directly affect or be directly affected by or have a bearing on the Board's decision in this appeal.

Status of Claims

Claims 1-18 stand rejected for the fifth time by the Office Action mailed August 25, 2006 and are presently under appeal in this proceeding. Claims 19-22 stand withdrawn from consideration for being drawn to a non-elected group.

Status of Amendments

No amendment has been filed subsequent to the Office Action mailed August 25, 2006.

Summary of Claimed Subject Matter

Independent Claim 1

Referring to Figure 2, independent claim 1 recites a tubular solid oxide fuel cell 10, comprising:

an air electrode 14 (see e.g. page 8 line 5 - page 9 line 2);

an electrolyte 16 formed on at least a portion of the air electrode 14 (see e.g. page 9 lines 3-21); and

a ceramic-metal fuel electrode 18 having a microstructure characterized by accumulated molten particle splats formed on at least a portion of the electrolyte (see e.g. page 9 line 21 – page 10 line 17, page 15 lines 13-16).

Dependent Claim 13

Referring to Figure 2, dependent claim 13 recites the fuel electrode 18 comprises nickel and zirconia, wherein a yttria stabilized zirconia powder comprises at least 7 mole percent of yttria (see e.g. page 14 lines 17-23).

Dependent Claim 14

Referring to Figure 2, dependent claim 13 recites the fuel electrode 18 comprises nickel and zirconia, wherein a yttria stabilized zirconia powder comprises at least 8 mole percent of yttria (see e.g. page 14 lines 17-23).

Dependent Claim 15

Referring to Figure 2, dependent claim 15 recites the electrolyte 16 comprises a rare-earth element stabilized zirconia (see e.g. page 9 lines 14-17).

Dependent Claim 18

Referring to Figures 2 and 4, dependent claim 18 recites a precursor layer 30 formed between the electrolyte 16 and the fuel electrode 18 (see e.g. page 16 line 15- page 17 line 8).

Grounds for Rejection to be Reviewed

(1) Whether claims 1-4, 9-12 and 15-17, particularly independent claim 1, are unpatentable under 35 U.S.C. § 102(b) as being anticipated by Ramanarayanan (High Temperature Ion Conducting Ceramics).

(2) Whether claims 1-4, 9-12 and 15-17, particularly independent claim 1, are unpatentable under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of what would have been obvious to one skilled in the art.

(3) Whether claims 1-8 and 12-18 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Cable in view of what would have been obvious to one skilled in the art.

(4) Whether claims 5-8 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of Jensen (USPN 5,035,962).

(5) Whether claims 9-11 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of Clemmer further in view of INCO, Ltd website (www.incosp.com).

(6) Whether claims 13 and 14 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of what would have been obvious to one skilled in the art.

(7) Whether claim 18 are unpatentable under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of Cable.

(8) Whether the Declaration of prior inventorship under 37 CFR 1.131 is sufficient to overcome Ramanarayanan.

Specifically, if any of the prior art discloses or suggests a ceramic-metal fuel electrode having a microstructure characterized by accumulated molten particle splats formed on at least a portion of the electrolyte. Molten particle splats are formed by and an inherent characteristic of plasma spraying.

Appellants' Argument

Applicants' Invention

A fuel cell converts chemical energy directly into electrical energy. Most fuel cells comprise a cathode or air electrode 1 and an anode or fuel electrode 3, separated by an electrolyte 5 (Fig. 1). At the air electrode, oxygen is ionized and the oxide ions migrate through the electrolyte to the fuel electrode 3. At the fuel electrode 3, hydrogen is ionized and the hydrogen ions react with the oxide ions to form water and release electrons. The released electrons then travel from the fuel electrode 3 to the air electrode 1 through a load-containing

connection, thereby completing the circuit and providing a small amount of direct electrical current. (spec. page 1 lines 15-22).

Because fuel cells are efficient, use plentiful and renewable fuels, do not require direct combustion and produce low emissions, they are a very attractive energy source. However, although the basic electrochemical processes and schematic arrangement of fuel cell based power generation systems are well understood, engineering solutions necessary to lower fabrication costs and make such systems an economical alternative to fossil fuel and other power generation systems remain elusive. (spec. page 2 lines 7-12).

One technical problem with conventional fuel cells involves the application of the fuel electrode to the electrolyte. The applied fuel electrode should advantageously possess and maintain certain properties during a lifetime of operation under fuel cell operating conditions with various fuels, including varying temperatures (e.g. about 25-1200°C, preferably about 700-1000°C) and pressures (e.g. about 0.5-5 atm, preferably about 1-5 atm). These properties include: high electrical conductivity, large electrochemically active interface area, high porosity, strong adherence to the electrolyte and interconnect, good chemical and physical stability, thermal cyclability, low fabrication costs, and long useful life. (spec. page 2 lines 13-21). Prior unsuccessful attempts to resolve this need are disclosed in spec. pages 2-4.

Applicants' invention resolves the need for a fuel electrode and a method for making the fuel electrode that can generally achieve above-described favorable technical properties and can be applied onto an underlying electrolyte at a low cost. (spec. page 4 lines 15-17).

<u>Response to Rejections</u>

(1) Claims 1-4, 9-12 and 15-17 stand rejected under 35 U.S.C. § 102(b), the Examiner contending that these claims are anticipated by Ramanarayanan.

Applicants' claims recite a tubular solid oxide fuel cell comprising a ceramic-metal <u>fuel electrode having a microstructure characterized by accumulated molten particle splats</u>. Ramanarayanan does not teach or suggest a fuel electrode having a microstructure characterized

by accumulated molten particle splats (which would be caused by plasma spraying), as contended by the Examiner. Rather, Ramanarayanan page 24 first paragraph discloses that the <u>anode (fuel electrode) is deposited by electrochemical vapor deposition (EVD), not plama spraying</u>.

Ramanarayanan page 23 last paragraph discloses that the <u>electrolyte</u> is deposited by EVD, and mentions that depositing the <u>electrolyte</u> by more cost-effective non-EVD techniques, such as plasma spraying or colloidal/electrophoric deposition followed by sintering, is being investigated (but not by whom). Applicants respectfully submit that Ramanarayanan's passing reference to an investigation into plasma spraying the electrolyte is not an enabling disclosure because it does not teach how to plasma spray the fuel cell electrolyte onto the underlying cathode. See MPEP 2121. For example, no spray parameters are provided or even hypothesized. For another example, no indication as to how the adherence, thermal stability, cyclibility etc. properties are achieved. Moreover, for at least these same exemplary reasons, Ramanarayanan's passing reference to the electrolyte certainly does not enable how to plasma spray the fuel electrode onto the underlying electrolyte.

Moreover, Applicants made these same arguments to the same rejection in its first appeal, and the Examiner found them to be persuasive. The only new contention that the Examiner now makes is that Ramanarayanan inherently discloses plasma spraying the fuel electrode. However, to make this argument, the Examiner submits the misstatement that "Ramanarayanan then goes on to teach the same anode film can be applied by a cost-effective non-EVD deposition technique". In fact, Ramanarayanan makes no such statement. In fact, Ramanarayanan only teaches that the <u>electrolyte</u> may be applied by a less costly plasma spraying technique. Thus, Ramanarayanan only repeats the conventional wisdom that the anode (fuel electrode) is applied by EVD and does not inherently teach plasma spraying the fuel electrode.

The Examiner also rejected claim 15 but fails to identify where Ramanarayanan discloses an electrolyte composition comprising a rare-earth element stabilized zirconia. In fact, p. 22 middle column of Ramanarayanan discloses that the electrolyte composition is ytrria stabilized

zirconia. Yttria is not a rare-earth element. See e.g. Rare Earth Periodic Table, www.chemicalelements.com/groups/rareearth.html.

(2) Claims 1-4, 9-12 and 15-17 stand rejected under 35 U.S.C. § 103(a) as being obvious over Ramanarayanan in view of what would have been obvious to one skilled in the art.

The Examiner contends that Ramanarayanan "clearly establishes plasma spraying as a cost effective deposition technique and it would be obvious to one skilled in the art to use the less expensive plasma spraying technique to apply the anode film over the more expensive EVD technique to reduce the production costs of the fuel cell."

Applicants agree that economics is a motivation toward invention, *in general*. More precisely, economics provides a motivation or natural tendency *to solve* a technical problem, *not how to solve* the technical problem. For example, economics would equally motivate one skilled in the art to consider solving the fuel electrode production cost problem by a lower cost EVD technique, or a colloidal/electrophoretic fuel electrode deposition technique, or a fuel electrode that is formed in-situ with the electrolyte, or a fuel electrode-less fuel cell, or any of a host of other fuel electrode production cost reduction inventions. A determination of motivation (or lack thereof) is properly made by considering the existing technical obstacles regarding a problem and weighting them against generally accepted ability to overcome them with routine experimentation. See e.g. *Micro Chemical Inc. v. Great Plains Chemical Co., Inc.*, 103 F.3d 1538 (Fed. Cir. 1997) (motivation may come from the nature of the problem to be solved). If economics alone was sufficient to confer motivation, then virtually everything would be unpatentable as a mere economic improvement over the prior art (lower cost, less defects, easier to handle, easier to use, longer lasting, faster, smaller, etc.). Thus, the Examiner's basis of motivation solely on economics improperly ignores the many opportunity costs inherent with attempting to plasma spray the fuel electrode rather that following a more conventional EVD approach, and also improperly ignores the significant technical obstacles that Applicants discovered and overcame and automatically renders them mere "routine experimentation". The

Attached Declaration under Sections 1.132 and 1.131 provides some examples of Applicants' non-routine experimentation.

To the Examiner's credit, a further motivational link is provided: "since a cost-effective non-EVD technique taught by Ramanarayanan [is] just a paragraph before is plasma spraying, one skilled in the art at the time of the invention would immediately envision plasma spraying as an alternative technique of applying the fuel electrode film." While Applicants agree that one *not skilled in the art* could consider textual proximity as motivation to plasma spray the fuel electrode, Applicants respectfully submit that one *skilled in the art* would immediately appreciate the significant technical obstacles associated with the plasma spraying the fuel electrode and agree with Ramanarayanan that it would be best to EVD the fuel electrode. See e.g. *Micro Chemical* (patentability upheld because "the invention solved the problem by going against the prior art"). As Applicants explained in its Background of the Invention section:

> Use of such plasma spraying techniques have been of limited value when used to apply a fuel electrode onto an electrolyte because they tend to result in a fuel electrode that poorly adheres to the electrolyte and exhibits poor thermal cyclability due to the mismatch of thermal coefficients of expansion between the metal portion of the fuel electrode and the ceramic electrolyte. Moreover, conventional plasma spraying techniques tend to result in a fuel electrode that has a low porosity after continued use, thereby causing voltage loss when current flows as a result of polarization due to a low rate of diffusion of fuel gasses into and reaction product out from the interface between the fuel electrode and the electrolyte. When plasma spraying an electrolyte, as Ramanarayanan suggests, these technical problems are not even considered.

Specification page 4 lines 6-14.

Applicants' inventive use of a ceramic-metal fuel electrode having a microstructure characterized by accumulated molten particle splats formed on a least a portion of the electrolyte addresses an unresolved problem in the prior art. There is no teaching in

Ramanarayanan of Applicants' particular solution to this particular problem. Applicants respectfully submit that the Examiner has succumbed to the insidious temptation of hindsight to conclude that the inventive features taught by Applicants are merely obvious design considerations. Only Applicants' specification teaches the particularly claimed combination, not the prior art. Applicants respectfully submit that it is improper for the Examiner to rely upon the level of ordinary skill in the art to supply what the Examiner was unable to find – either the claimed combination or a suggestion to modify:

> The level of skill in the art is a prism or lens through which a judge or jury views the prior art and the claimed invention. This reference point prevents these deciders from using their own insight or, worse yet, hindsight, to gauge obviousness. *Rarely, however, will the skill in the art component operate to supply missing knowledge or prior art to reach an obviousness judgment.* *See W.L. Gore & Assocs., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 1553, 220 USPQ 303, 312-13 (Fed. Cir. 1983) ("To imbue one or ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references or record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against the teacher.').

Al-Site Corp. v. VSA Int'l., Inc., 174 F.3d 1308, 1324, 50 U.S.P.Q.2d 1161, 1177 (Fed. Cir. 1999) (emphasis added).

This is not one of those cases where the level of skill can supply a missing claim limitation or suggestion to modify the prior art, especially since it is the inventive features of the claimed invention that are not shown or suggested by the prior art.

The Examiner also rejected claim 15 but fails to identify where Ramanarayanan discloses or suggests an electrolyte composition comprising a rare-earth element stabilized zirconia. In fact, p. 22 middle column of Ramanarayanan discloses that the electrolyte composition is ytrria

stabilized zirconia. Yttria is not a rare-earth element. See e.g. Rare Earth Periodic Table, www.chemicalelements.com/groups/rareearth.html.

(3) Claims 1-8 and 12-18 stand rejected under 35 U.S.C. § 103(a), the Examiner contending that these claims are obvious over Cable in view of what would have been obvious to one skilled in the art.

Cable does not teach or suggest a <u>tubular</u> <u>fuel electrode</u> having a microstructure characterized by accumulated molten particle splats (which would be caused by <u>plasma spraying</u>), as contended by the Examiner. Rather, Cable 8:30-35 teaches that a very thin fuel electrode <u>interfacial layer 19, not the fuel electrode 4</u> may be formed by other techniques such as plasma deposition, spin casting, spraying or screen printing. Cable also goes into significant detail teaching away and distinguishing its planar fuel cell design from the claimed tubular fuel cell design, explaining that its invention is directed to fuel cells which are tolerant of sulfur-bearing fuels (1:15-17) and that tubular fuel cells are intolerant of sulfur bearing fuels (1:25-30, 1:55-2:59).

The Examiner further contends that it would be obvious "to recognize plasma spraying as a viable option for also applying the anode material." However, the Examiner provides no motivation in Cable to support this contention. Applicants therefore respectfully that the Examiner has failed to set forth a proper 103(a) rejection, and also repeats the motivation argument set forth above in connection with Ramanarayanan 103(a) rejection.

The Examiner also rejected claims 13 and 14 but fails to identify where Cable discloses or suggests a fuel electrode comprising at least 7 or 8 mole percent of yttria. In fact, col. 10 lines 18-30 of Cable are silent as to any mole percent of yttria.

The Examiner also rejected claim 15 but fails to identify where Cable discloses or suggests an electrolyte composition comprising a rare-earth element stabilized zirconia. In fact,

col. 8 lines 11-18 of Cable discloses that the electrolyte composition is ytrria stabilized zirconia. Yttria is not a rare-earth element. See e.g. Rare Earth Periodic Table, www.chemicalelements.com/groups/rareearth.html.

The Examiner also rejected claim 18 but fails to identify where Cable discloses or suggests a precursor layer formed between the electrolyte and the fuel electrode. Rather, the Examiner mis-cites an interfacial layer formed between the electrolyte.and the air electrode.

(4) Dependent claims 5-8 stand rejected under 35 U.S.C. § 103(a), the Examiner contending that these dependent claims are obvious over Ramanarayanan in view of Jensen (USPN 5,035,962)..

Applicants respectfully submit that none the cited references, alone or in combination, teach or suggest a fuel electrode having a microstructure characterized by accumulated molten particle splats (which would be caused by plasma spraying). Thus, the Examiner's identification of elements recited in the dependent claims cannot render the dependent claims unpatentable since the dependent claims include the limitations of patentable independent claim 1.

(5) Dependent claims 9-11 stand rejected under 35 U.S.C. § 103(a), the Examiner contending that these dependent claims are obvious over Ramanarayanan in view of Clemmer further in view of INCO, Ltd website (www.incosp.com).

Applicants respectfully submit that none the cited references, alone or in combination, teach or suggest a fuel electrode having a microstructure characterized by accumulated molten particle splats (which would be caused by plasma spraying). Thus, the Examiner's identification of elements recited in the dependent claims cannot render the dependent claims unpatentable since the dependent claims include the limitations of patentable independent claim 1.

(6) Dependent claims 13 and 14 stand rejected under 35 U.S.C. § 103(a), the Examiner contending that these dependent claims are obvious over Ramanarayanan in view of in view of what would have been obvious to one skilled in the art.

Applicants respectfully submit that none the cited references, alone or in combination, teach or suggest a fuel electrode having a microstructure characterized by accumulated molten particle splats (which would be caused by plasma spraying). Thus, the Examiner's identification of elements recited in the dependent claims cannot render the dependent claims unpatentable since the dependent claims include the limitations of patentable independent claim 1.

(7) Dependent claim 18 stands rejected under 35 U.S.C. § 103(a), the Examiner contending that these dependent claims are obvious over Ramanarayanan in view of in view of Cable.

Applicants respectfully submit that none the cited references, alone or in combination, teach or suggest a fuel electrode having a microstructure characterized by accumulated molten particle splats (which would be caused by plasma spraying). Thus, the Examiner's identification of elements recited in the dependent claims cannot render the dependent claims unpatentable since the dependent claims include the limitations of patentable independent claim 1.

(8) The declaration of prior inventorship under 37 CFR 1.131 filed on February 18, 2005 stands ineffective to overcome the Ramanarayanan reference for: (a) not sufficiently establishing a conception of the invention prior to the effective date of the Summer 2001 Ramanarayanan reference, and (b) not sufficiently establishing diligence from a date prior to the date of reduction to practice of Ramanarayanan to either: (i) a constructive reduction to practice or (ii) an actual

reduction to practice because multiple large gaps in time are present without any supporting evidence that a reduction to practice was diligently being practiced.

Applicants respectfully submit that the Declaration was initially submitted with its first Office Action response in order to overcome the cited Hui reference (USPAN 2004/0018409). Faced with the Declaration, the Examiner withdrew the Hui reference in the second Office Action mailed April 13, 2005 explaining that "The declaration of prior ownership filed on 18 February 2005 under 37 CFR 1.131 is sufficient to overcome the Schmidt reference", and instead cited the Schmidt reference (USPAN 2004/0058225). Applicants second Office Action response resubmitted the same Declaration in order to overcome the Schmidt reference. Faced again with the Declaration, the Examiner withdrew the Schmidt reference in the third Office Action.

Now, after finding the Declaration to sufficient to overcome two cited art references on two separate occasions, the Examiner now states that the Declaration stands ineffective.

"Conception must be proven by corroborating evidence that shows that the inventor disclosed to others his completed thought so as to enable those skilled in the art to make the invention." Northern Telecom Inc. v. Datapoint Corp. 9 USPQ2d 1577, 1623, (N.D. Tex. 1988), aff'd in part, rev'd in part, 908 F.2d 931, 15 USPQ2d (Fed. Cir. 1990). It is respectfully submitted that the Invention Disclosure proves conception by March 2, 2001. The Invention Disclosure form was signed March 2, 2001 by the inventors and explained to a witness on the same date. March 2, 2001 is clearly prior to the Summer 2001. Moreover, pages 4 and 5 of the Invention Disclosure form discusses plasma spraying the fuel electrode. Also, the chart on Page 6 demonstrates a preliminary plasma sprayed fuel electrode test that was performed on March 1, 2001.

Diligence is shown "when there is a continuous course of activity, carried on without significant interruption and accomplished in a reasonably prompt manner, considered in light of all the attendant circumstances." Diasonics, Inc. v. Acuson Corp. 1993 WL 248654 * 16 (N.D. Cal. 1993). Proof of diligence "does not require a party to work constantly on the invention or to drop all other work." Bey v. Kollonitsch, 806 F.2d 1024, 1028, 231 USPQ 967, 970 (Fed. Cir. 1986). It is respectfully submitted that the Declaration and presently submitted Supplemental

Declaration demonstrate such continuous course of activity carried on without significant interruption.

F. <u>Conclusion</u>

For the foregoing reasons, Applicants respectfully submit that the rejections set forth in the final Office Action are inapplicable to the pending claims. The honorable Board is therefore respectfully requested to reverse the final rejection of the Examiner and to remand the application to the Examiner with instructions to allows the pending claims. Please grant any extensions of time required to enter this paper. Please charge any appropriate fees due in connection with this paper or credit any overpayments to Deposit Account No. 19-2179.

Respectfully submitted,

Dated: 12/7/06

By: [signature]

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Claims Appendix

1. A tubular solid oxide fuel cell, comprising:

an air electrode;

an electrolyte formed on at least a portion of the air electrode; and

a ceramic-metal fuel electrode having a microstructure characterized by accumulated molten particle splats formed on at least a portion of the electrolyte.

2. The fuel cell of claim 1, wherein the air electrode composition comprises lanthanum manganite.

3. The fuel cell of claim 1, wherein the electrolyte composition comprises yttria-stabilized zirconia.

4. The fuel cell of claim 1, wherein the ceramic-metal fuel electrode composition comprises nickel and zirconia.

5. The fuel cell of claim 4, wherein the fuel electrode composition comprises at least 60% nickel and at least 15% zirconia.

6. The fuel cell of claim 5, wherein the fuel electrode composition comprises at least 70% nickel and at least 20% zirconia.

7. The fuel cell of claim 4, wherein the fuel electrode composition comprises no more than 85% nickel and no more than 40% zirconia.

8. The fuel cell of claim 7, wherein the fuel electrode composition comprises no more than 80% nickel and no more than 30% zirconia.

9. The fuel cell of claim 4, wherein a nickel graphite powder is used to obtain at least a portion of the nickel.

10. The fuel cell of claim 9, wherein the nickel graphite powder comprises at least 60% nickel and at least 15% graphite.

11. The fuel cell of claim 10, wherein the nickel graphite powder comprises at least 70% nickel and at least 20% graphite.

12. The fuel cell of claim 4, wherein a yttria stabilized zirconia powder is used to obtain at least a portion of the zirconia.

13. The fuel cell of claim 12, wherein the yttria stabilized zirconia powder comprises at least 7 mole percent of yttria.

14. The fuel cell of claim 13, wherein the yttria stabilized zirconia powder comprises at least 8 mole percent of yttria.

15. The fuel cell of claim 1, wherein the electrolyte composition comprises a solid oxide comprising a rare-earth element stabilized zirconia.

16. The fuel cell of claim 1, wherein the tubular solid oxide fuel cell further comprises an interconnect that interconnects a plurality of tubular solid oxide fuel cells.

17. The fuel cell of claim 16, wherein the interconnected tubular solid oxide fuel cells form a power generation system.

18. The fuel cell of claim 1, wherein the fuel cell further comprises a precursor layer formed between the electrolyte and the fuel electrode, the precursor layer composition comprising zirconia and having a thickness of about 5 um to about 20 um.

19. (withdrawn) A method of manufacturing a fuel cell, comprising:

providing an air electrode;

arranging an electrolyte adjacent the air electrode; and

plasma spraying a ceramic-metal fuel electrode powder onto at least a portion of the electrolyte with a plasma spray gun.

20. (withdrawn) The method of claim 17, wherein the powder has a gun feed rate of about 6 grams per minute to about 30 grams per minute, and a distance of about less than 4 inches between the gun and the electrolyte.

21. (withdrawn) The method of claim 17, wherein the spray gun has a discharge voltage of about 30-60 volts, a current of about 400-900 amperes, and a power of about 10-40 kilowatts.

22. (withdrawn) The method of claim 19, wherein the spray gun moves at a rate of about 400 mm/sec to about 700 mm/sec and the electrolyte makes about 2-40 revolutions around the spray gun to form the fuel electrode.

Evidence Appendix

None

Related Proceedings Appendix

None